Forum for Electromagnetic Research Methods and Application Technologies (FERMAT)

Miniaturized Multiband Antenna with Modified Split-ring Resonator for WLAN/WiMAX Applications

by:

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Abstract: A novel compact and planar tri-band antenna having frequency beam-scanning ability is designed using a metamaterial-inspired structure. The metamaterial (MTM) configuration consists of a marginally remodeled split-ring resonator (SRR). The antenna has a unique ground plane with a comb structure. The proposed design has dimensions 20 x 20 x 1.6 mm3. It resonates at 2.351, 3.635 and 5.121 GHz respectively which is suited for LTE2300, WiMAX and WLAN applications. Radiation pattern shifts 900 for a change 0.2 GHz in the range 3.8 - 4GHz providing beam steering applicable for MIMO LTE (4G) and WiMAX.

Keywords: metamaterial, modified split-ring resonator, comb-like ground plane, beam scanning ability, WiMAX, WLAN, LTE2300, MIMO LTE.

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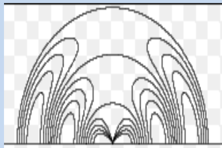


7th July, 36th PIERS 2015 at Prague, Czech Republic

Current research

1. Metamaterial antennas exhibit:
- Multiband feature
- Compactness

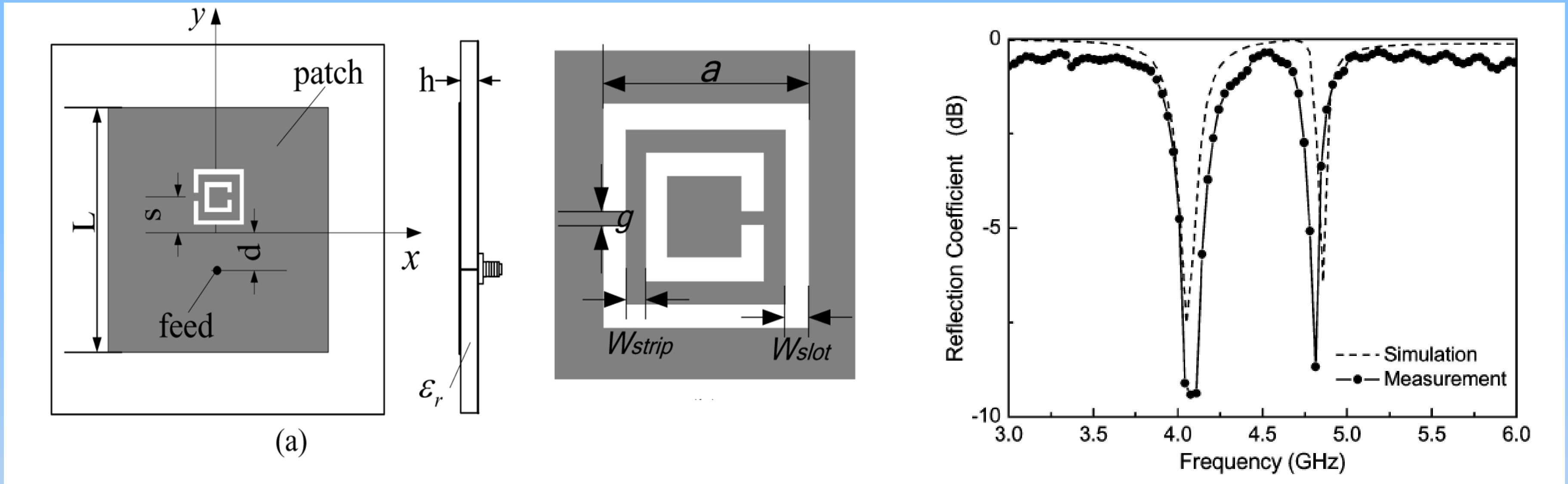
2. Leaky-wave antennas exhibit:
- Beam steering ability

Objective

To design an antenna incorporating features of both Metamaterial antenna and Leaky Wave antenna

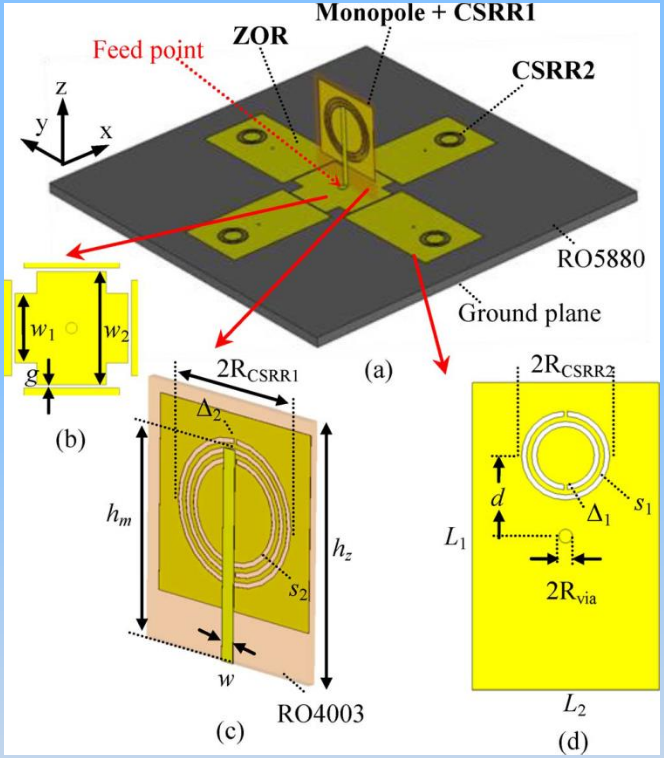
Previous Designs

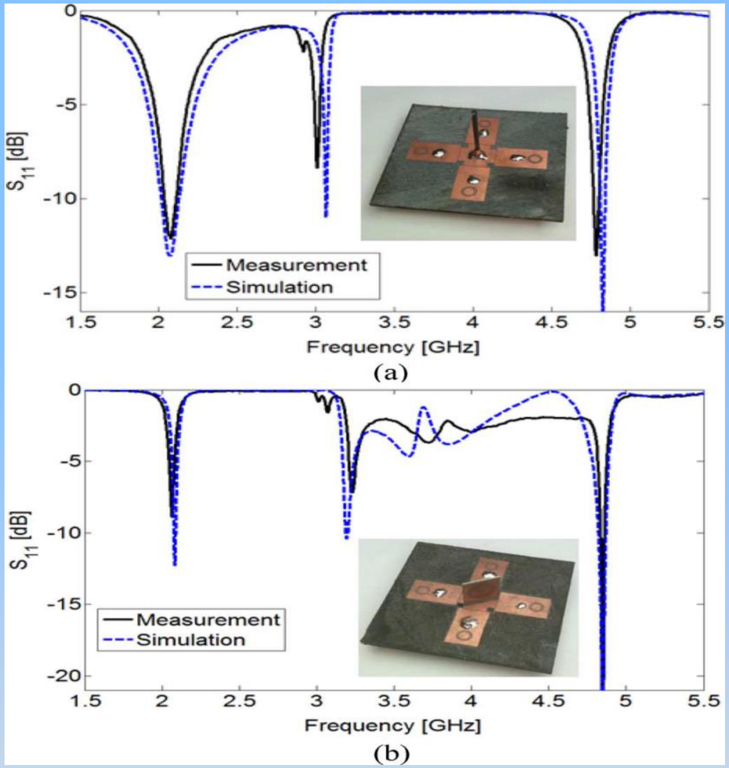
1. Split Ring resonator antenna



Zhang, Hui, et al. "Design of circular/dual-frequency linear polarization antennas based on the anisotropic complementary split ring resonator." *Antennas and Propagation, IEEE Transactions on* 57.10 (2009): 3352-3355.

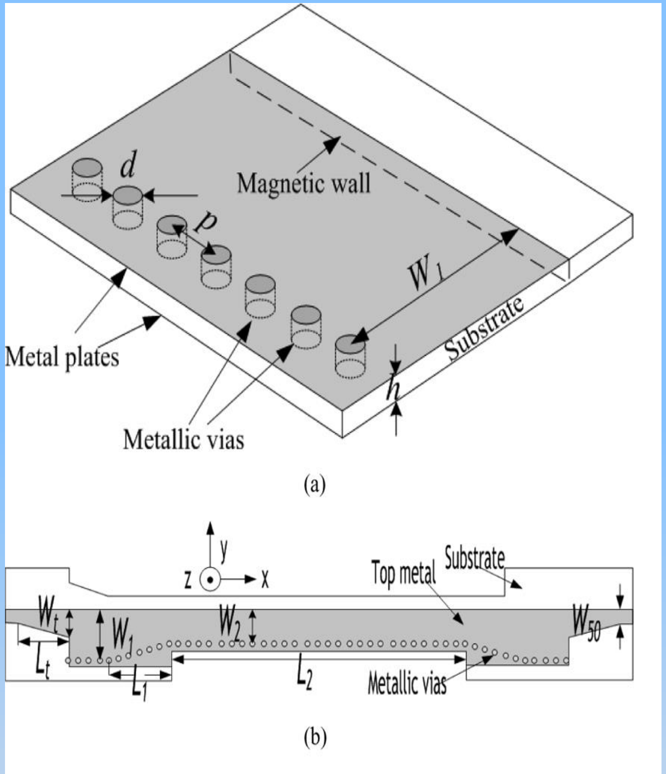
2. Split Ring resonator antenna


Monopole + CSRR1
ZOR
Feed point
CSRR2
z
y
x
RO5880
Ground plane
(a)
w_1
w_2
g
(b)
$2R_{CSRR1}$
Δ_2
h_m
h_z
s_2
w
RO4003
(c)
$2R_{CSRR2}$
d
Δ_1
s_1
L_1
$2R_{via}$
L_2
(d)

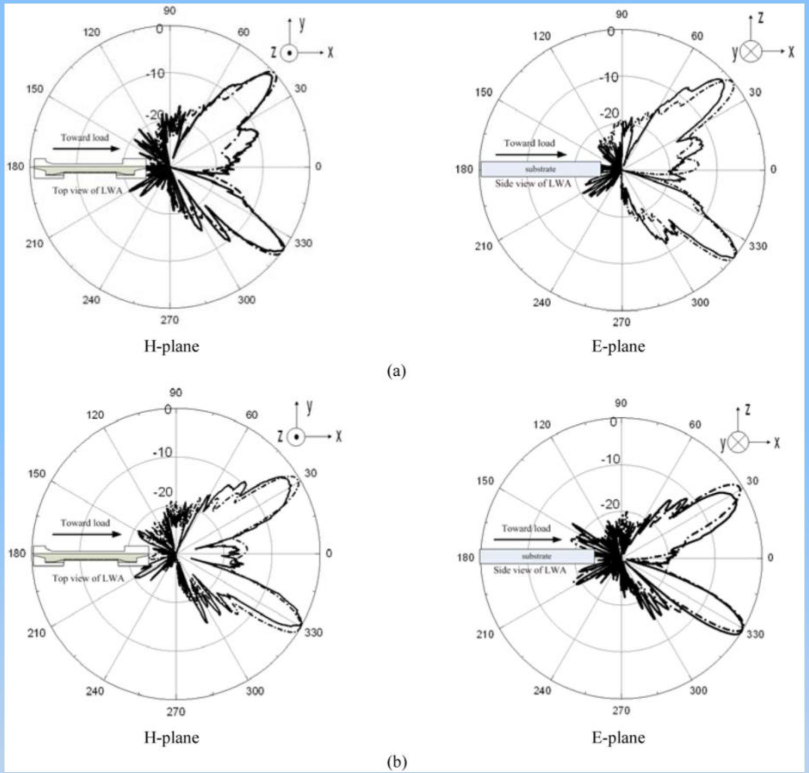


Mehdipour, Aidin, Tayeb Denidni, and Abdel-Razik Sebak. "Multi-band miniaturized antenna loaded by ZOR and CSRR metamaterial structures with monopolar radiation pattern." *Antennas and Propagation, IEEE Transactions on*62.2 (2014): 555-562.

2. Leaky wave antenna

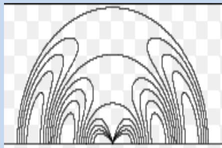


d
Magnetic wall
p
W1
Substrate
Metal plates
h
Metallic vias
(a)
y
z
x
Top metal
Substrate
Wt
W1
W2
W50
Lt
L1
L2
Metallic vias
(b)



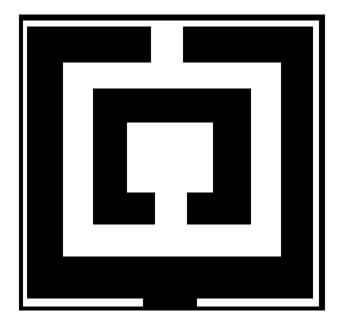
Measured (solid lines) and simulated (dashed lines) radiation patterns. (a) 26.5 GHz and (b) 28 GHz.

Xu, Junfeng, et al. "Half-mode substrate integrated waveguide (HMSIW) leaky-wave antenna for millimeter-wave applications." *Antennas and Wireless Propagation Letters, IEEE* 7 (2008): 85-88.



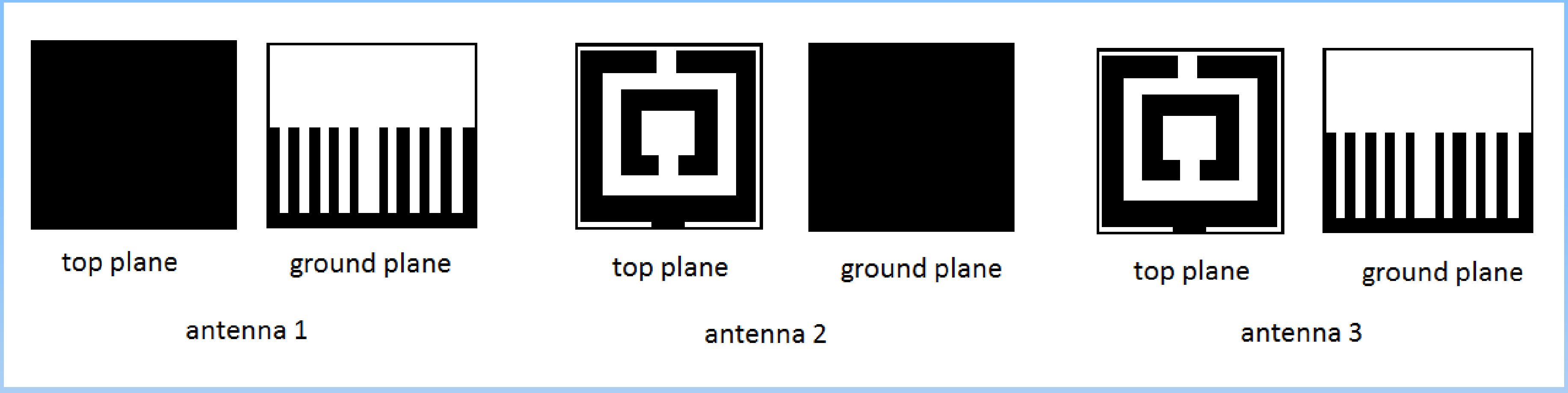
Design Agenda

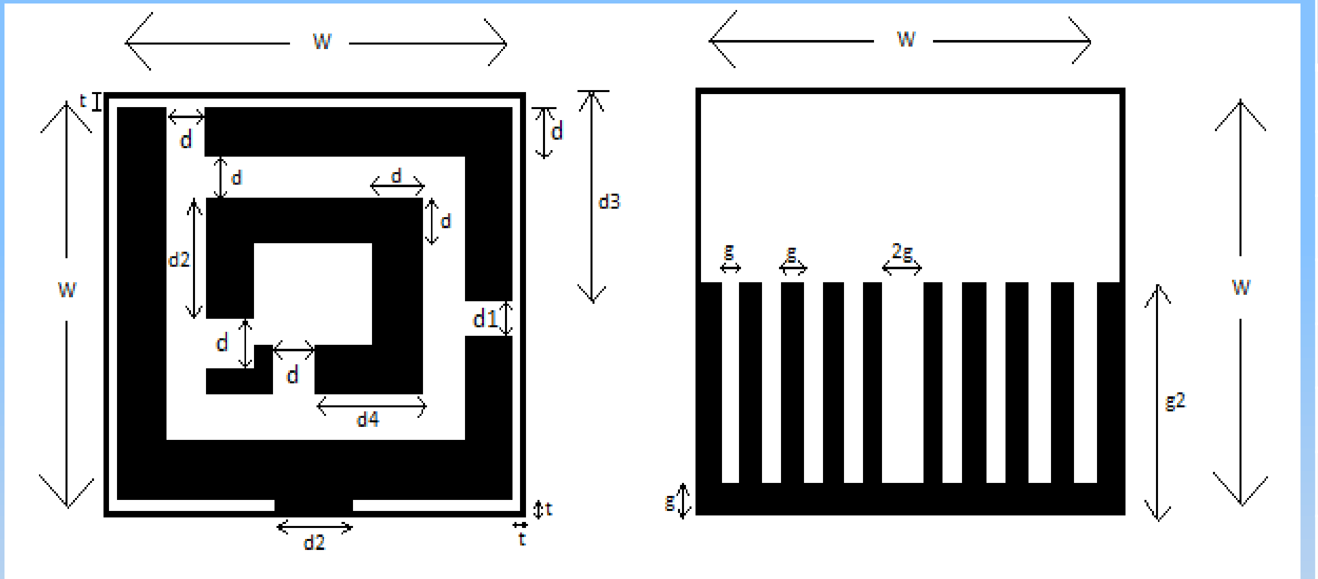
- Modification of conventional SRR and use of comb-like structure for ground plane
- Design a tri-band antenna at 2.351, 3.635 and 5.121 GHz
- Beam steering with frequency change ability between 3.8-4 GHz
- Compact size of 20 x 20 x 1.6 mm^3



A typical SRR structure

Proposed designs

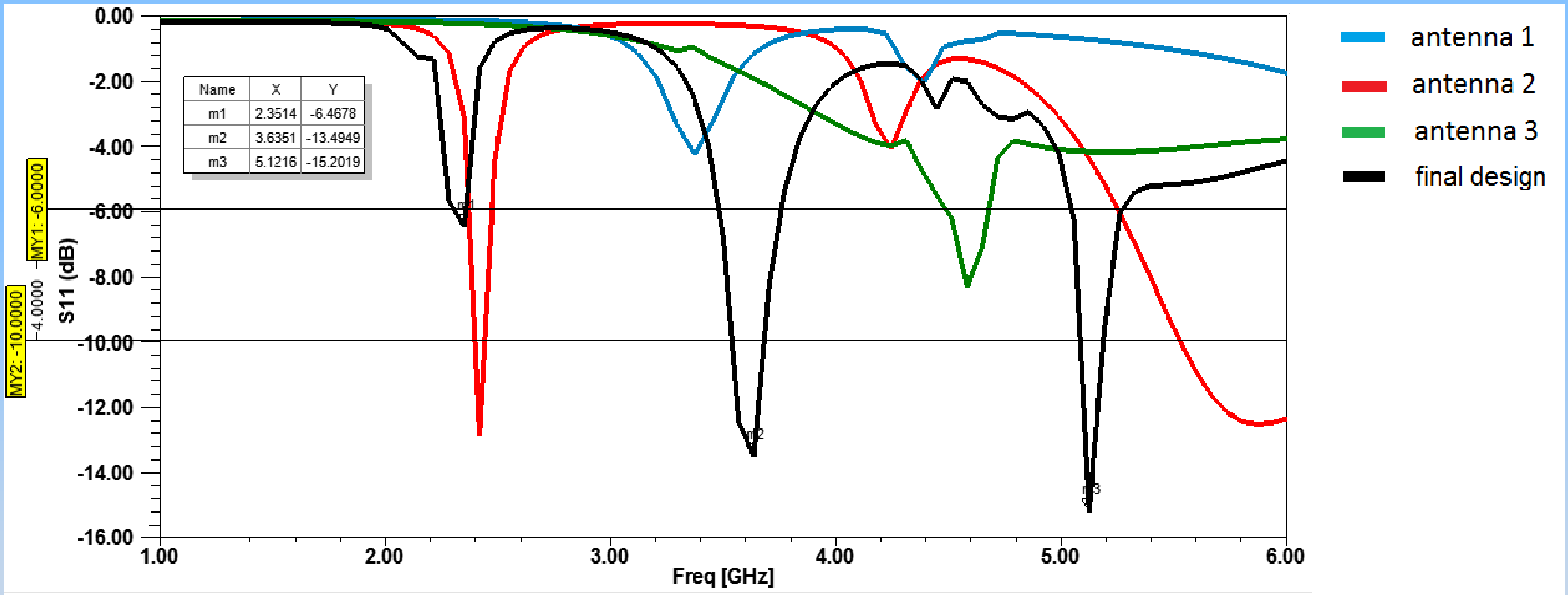

top plane
ground plane
antenna 1
top plane
ground plane
antenna 2
top plane
ground plane
antenna 3


w
t
d
d
d
d
d
d
d
d2
d1
d3
d4
w
t
t
d2
w
g
g
2g
g2
w
g

Final design

Parameter	Dimension (mm)
w	20
d	2
d1	1.5
d2	7
d3	9.75
d4	4
t	1
g	1
g2	10

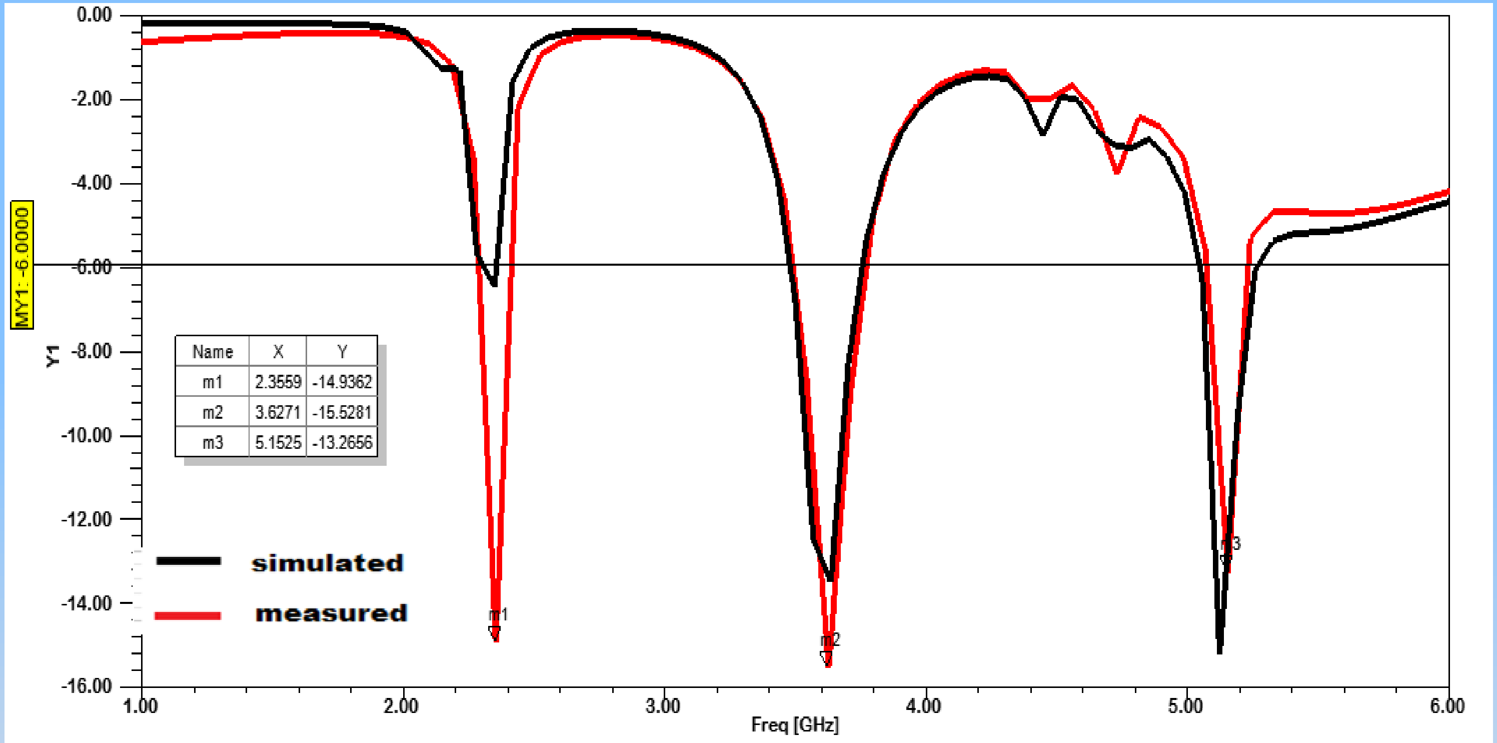
Result of parametric analysis



Name	X	Y
m1	2.3514	-6.4678
m2	3.6351	-13.4949
m3	5.1216	-15.2019

Sl. No.	Antenna type	Resonant Frequencies (GHz)
1	Antenna 1	3.4, 4.4
2	Antenna 2	2.4, 5.9
3	Antenna 3	4.5
4	Final design	2.35, 3.63, 5.12

Simulated and measured S_{11}



Name	X	Y
m1	2.3559	-14.9362
m2	3.6271	-15.5281
m3	5.1525	-13.2656

Resonant frequency (bandwidth):

2.351GHz (5MHz)
3.635GHz (140MHz)
5.121GHz (96MHz)

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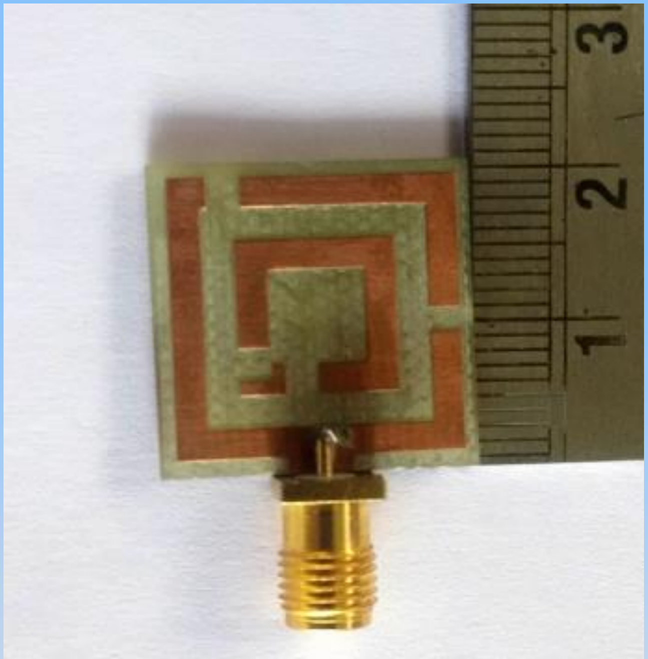
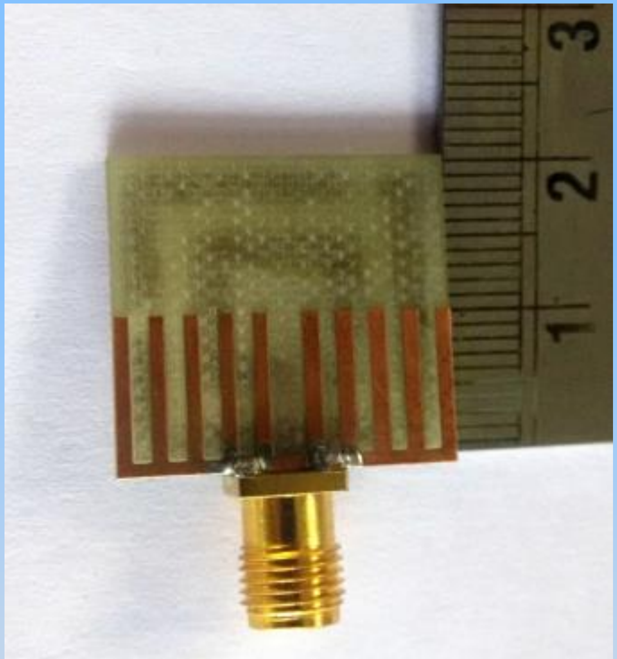
Fabricated antenna

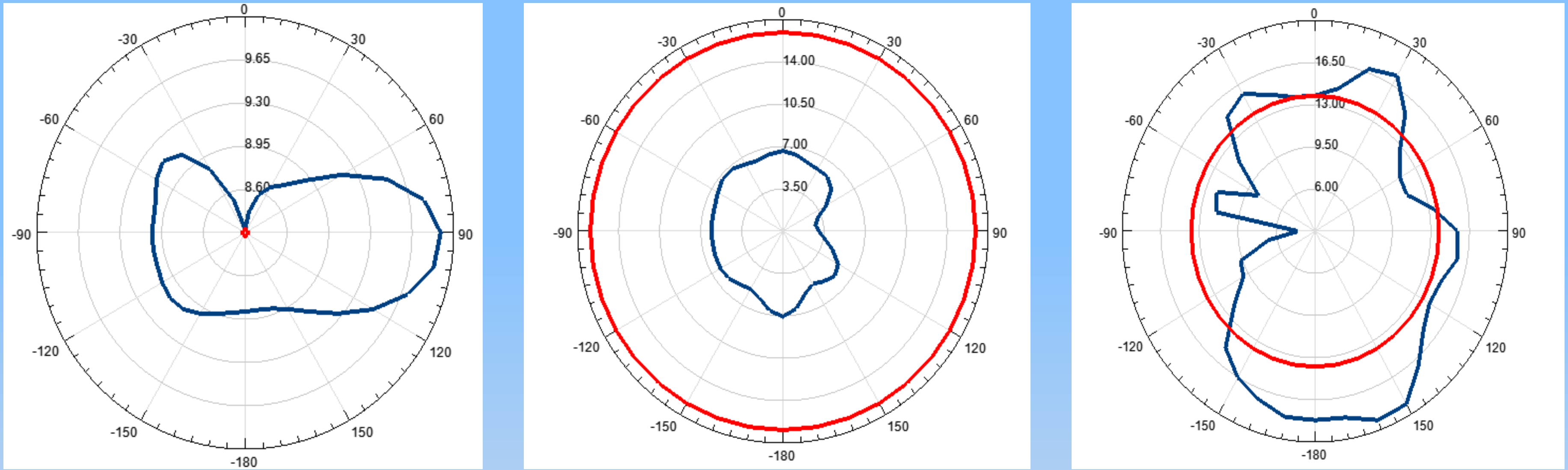


Top plane



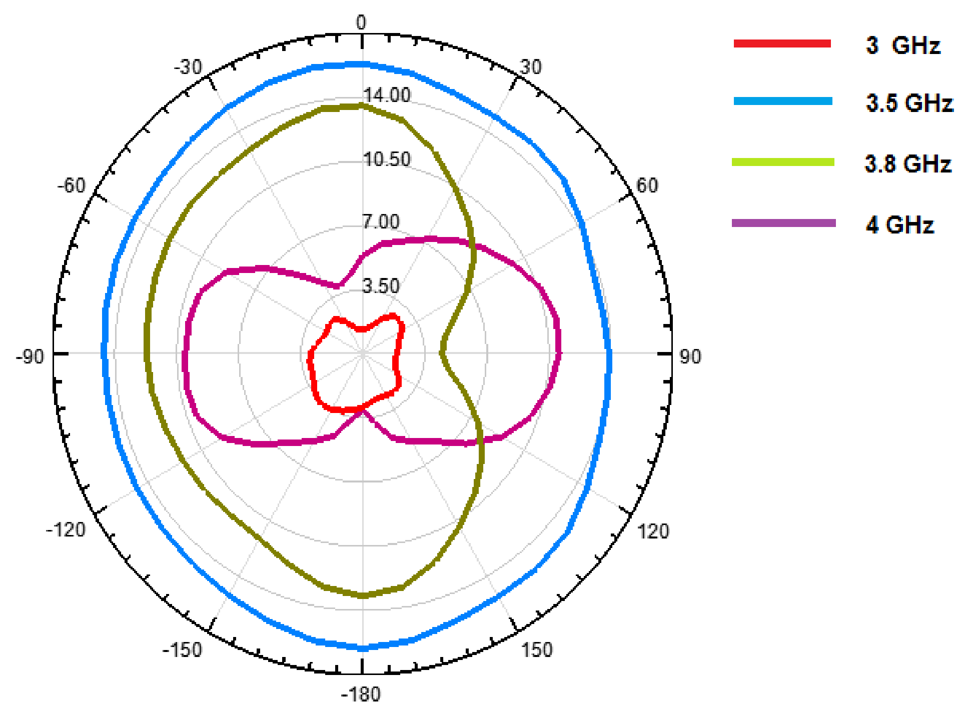
Ground plane

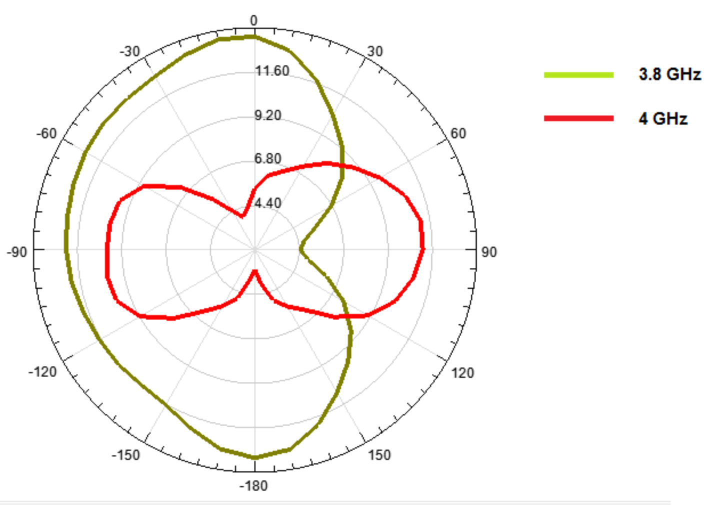
2D Radiation Patterns

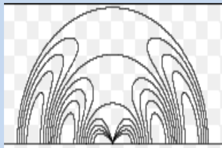


Radiation pattern along E plane (red) and H plane (blue) at 2.35 GHz, 3.63 GHz & 5.12 GHz

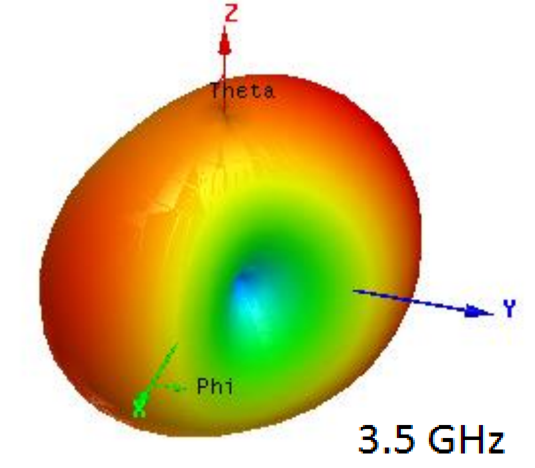
Variation in Radiation Pattern with Frequency Change Showing 90^0 shift in radiation pattern seen between 3.8-4 GHz

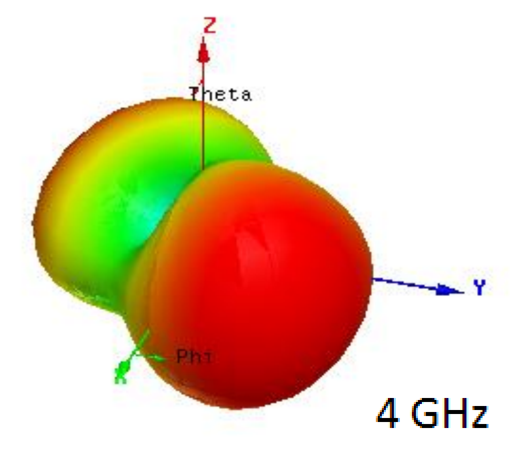


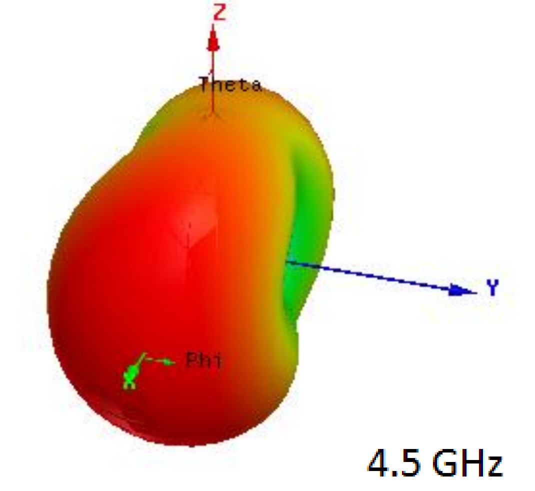


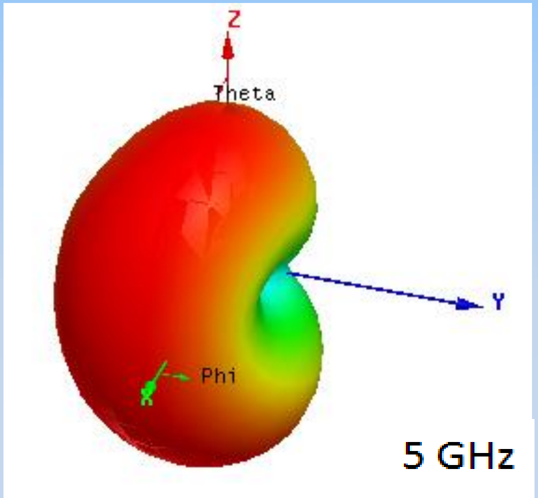


3D Radiation Patterns


Z
Theta
Y
Phi
3.5 GHz


Z
Theta
Y
Phi
4 GHz


Z
Theta
Y
Phi
4.5 GHz


Z
Theta
Y
Phi
5 GHz

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